

Survey on the use and practice of transcranial Doppler ultrasound in neurocritical patients in pediatric intensive care units in Argentina

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ABSTRACT

Introduction. The use of transcranial Doppler (TCD) ultrasound in neurocritical patients is reported to be increasingly common in pediatric intensive care units. The objective of this survey was to know about the use and practice of TCD ultrasound in neurocritical care and the training process of staff members performing it.

Materials and methods. Survey administered to providers from 23 pediatric intensive care units of Argentina.

Results. The percentage of response was 86%. TCD ultrasound was used for suspected brain death (n = 20), head injury (n = 16), and stroke (n = 16). Pediatric intensivists perform the test (n = 13/20). Surveyed participants use TCD ultrasound to decide on treatment and management, start brain death assessment, request brain computed tomography, and manage cerebral perfusion pressure with vasopressors.

Conclusion. All surveyed participants use TCD ultrasound findings to guide management or treatments. Half of surveyed participants are little satisfied with their training.

Key words: transcranial Doppler ultrasound, critical care, neurology, pediatrics.

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INTRODUCTION

Acute neurological injuries account for 10% of admissions to pediatric intensive care units (PICUs) in Argentina.¹ The use of transcranial Doppler (TCD) ultrasound in critically ill children is reported to be increasingly common in PICUs.^{2,4}

TCD ultrasound is a non-invasive assessment of the intracranial arterial blood flow velocity.⁵

The clinical indications for a TCD ultrasound are increasing, although scanning protocols and reporting quality vary across facilities.³

In relation to neuromonitoring, the Sociedad Argentina de Pediatría (SAP) and the Sociedad Argentina de Terapia Intensiva (SATI) recommend having TCD ultrasound equipment available for patients with neurocritical conditions.⁶ According to a survey conducted by Neira et al., in 2017, TCD ultrasound was used in 20 out of 76 PICUs.⁷

The objective of this survey was to know about the use and practice of TCD ultrasound in neurocritical care and the training process of staff members performing it.

MATERIAL AND METHODS

This study consisted of a survey with a sample selected by convenience. A questionnaire of 23 multiple choice questions was created (*Supplementary material 1*) and sent by e-mail or telephone to representatives of neurocritical care working at the PICUs of Argentina where TCD ultrasound equipment is currently available. Only 1 response was allowed for each unit.

A pilot test was conducted with 10 users who were representative of the target population to be surveyed to assess questions clarity and the time it took to complete it.

Informed consent for participation and data use was requested.

The protocol and the survey were submitted and approved by the Department of Teaching and Research of Hospital Provincial Neuquén.

A descriptive, cross-sectional analysis and an analysis of the semi-structured section of the

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survey were done. Categorical outcome measures are described as n and rate (%). Data were entered into an Excel® spreadsheet and analyzed with the R® software.

RESULTS

A total of 23 surveys were delivered and 20 were completed (86%).

Table 1 shows the geographic distribution of PICUs where surveyed participants work. Fifteen of them work in a public facility. Sixteen indicate that the PICU where they work does not have a neurocritical care unit.

Pediatric intensivists perform TCD ultrasounds at the unit (n = 13/20) and the same operator is responsible for interpreting the report (n = 17).

Figure 1 shows the training received by operators.

In relation to training in TCD ultrasound,

TABLE 1 Geographic distribution of units where surveyed providers work

City	Surveyed participant (n)
CABA	7
Province of Buenos Aires	4
Chubut	1
Corrientes	1
Formosa	1
Neuquén	1
Rio Negro	1
Salta	1
San Juan	1
Santa Fe	1
Tucumán	1

CABA: The City of Buenos Aires.

8 surveyed participants are satisfied with the training they received, but 10 of them are little satisfied with the training received in the pediatric field. Supplementary material 2 shows the answers from surveyed participants. Sixteen providers refer that they received additional training in pediatric neurocritical care; i.e., they took courses or completed rotations in neurocritical care. Twelve surveyed participants report that they do not have a protocol in place for TCD ultrasound indication; in addition, 13 do not have a protocol for TCD ultrasound standards (technique, depth, sample volume, power, gain, and velocities).

According to 11 surveyed participants, the test report is part of the patient's medical record. Fifteen of them perform the complete test, i.e., they scan anterior and posterior brain territories.

Figure 2 shows the clinical situations or conditions for which TCD ultrasound monitoring is performed.

All surveyed participants use TCD ultrasound to decide on treatment and management.

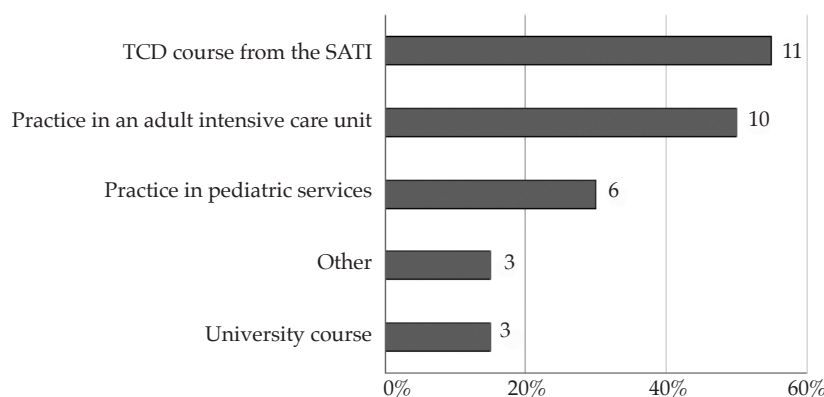
Figure 3 shows the changes carried out based on TCD ultrasound findings.

Twelve surveyed participants mentioned that they measure cerebral self-regulation; 7 of them perform a transient hyperemic response test and 5 monitor drug-induced hypertension.

Also, 13 referred that they do not offer long-term follow-up for neurocritical patients who undergo TCD ultrasound and receive treatment based on test results.

All PICUs (n = 20) use TCD ultrasound as an ancillary test in patients older than 2 years with suspected brain death. The test was performed by staff of the National Institute for Organ and

FIGURE 1. Operator training (n = 20)*



* Some operators took more than one training course.

TCD: transcranial Doppler ultrasound; SATI: Sociedad Argentina de Terapia Intensiva.

Tissue Procurement for Transplantation (n = 7), imaging test specialists (n = 3), neurologists (n = 2), and adult intensivists (n = 2).

Seventeen surveyed participants do not use test results for research purposes.

DISCUSSION

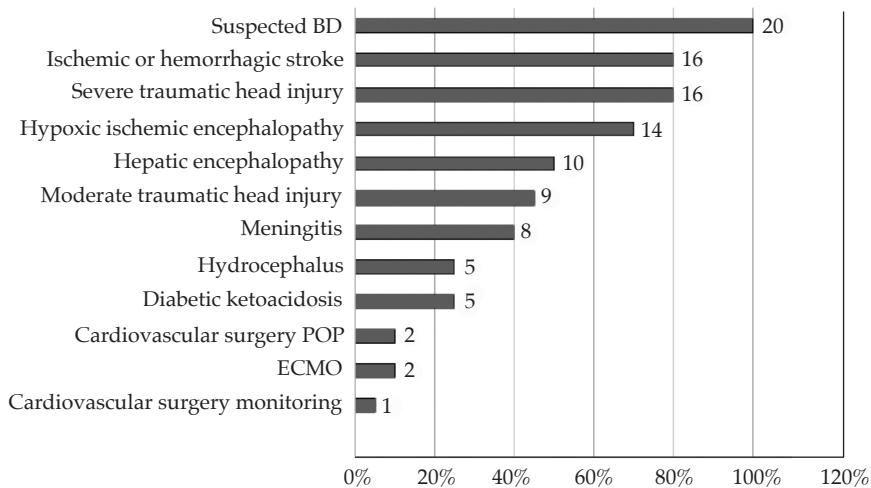
Although there are no good-quality and outcome studies, TCD ultrasound findings appear to have an impact on treating pediatric

neurocritical patients.⁸

Its use in children with sickle-cell anemia is effective to assess the risk for stroke and is the only indication with grade A recommendation, class I evidence.⁹

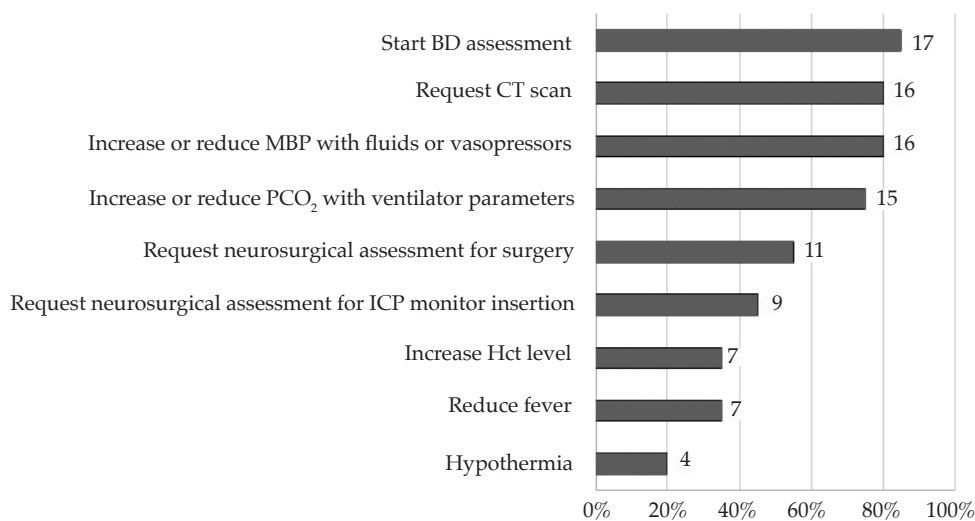
When comparing the results of the survey conducted as part of this study with those of another survey administered in the United States, it is observed that most surveyed participants lack an exclusive neurocritical care unit, whereas

FIGURE 2. Clinical situations or conditions for which transcranial Doppler ultrasound monitoring is performed (n = 20)



BD: brain death, ECMO: extracorporeal membrane oxygenation, POP: postoperative period.

FIGURE 3. Changes based on findings from transcranial Doppler ultrasound monitoring



BD: brain death; MBP: mean blood pressure; CT: computed tomography; PCO₂: partial pressure of carbon dioxide; Hct: hematocrit; ICP: intracranial pressure.

the survey by LaRovere et al.,³ was conducted at hospitals that belong to a group of pediatric neurocritical care research.

Half of the surveyed participants were not satisfied with their training. In a consensus practice recommendation published by O'Brien et al.,⁸ it was not possible to reach a consensus about the training and certification process recommended for the performance and interpretation of TCD ultrasound in the intensive care unit. For tests done for clinical purposes, whose report is attached to the patient's medical record, the consensus is that the operator performing the test and the physician interpreting the results should be authorized by the accreditation organization corresponding to their facility.

Most surveyed participants do not have a protocol in place for standardized data acquisition. In the field of clinical research, the lack of test standards restricts the possibility of generalizing results at research sites and between studies.⁸

All surveyed participants use TCD ultrasound in cases of suspected brain death; more than half of the participants diagnose circulatory arrest as an ancillary test in patients older than 2 years as part of the brain death diagnostic protocol based on neurological criteria, and 35% is done by pediatric intensivists. In addition, most surveyed participants start the brain death assessment process based on TCD ultrasound findings; however, there is yet no protocol for the technical standards of this type of test (filters, envelope signal).

This information contradicts the survey by LaRovere et al.,³ which excludes the use of TCD ultrasound for brain death due to its unknown specificity in pediatric patients.

In Argentina, children may be assessed as of 2 years old according to National Law no. 27447.^{10,11}

In a study carried out to establish the variability in brain death protocols based on neurological criteria in the field of pediatrics among children's hospitals in the United States,¹¹ and compared with the 2011 guidelines,¹² 15% performed ancillary tests in all patients and 15% performed complementary tests that have not been validated in pediatrics.¹¹

The recommendation is to have a minimum number of documented tests, approved by a legal guardian, and a theoretical examination for the certification of the physician to diagnose cerebral

circulatory arrest to support the legal diagnosis of brain death.¹³

In relation to the sample presented in this study, all surveyed participants use TCD ultrasound findings to guide treatments, compared to 74% of those surveyed in the study by LaRovere et al.,³ in spite of the lack of published data showing an impact on outcomes. Further research studies are required to assess the impact on outcomes based on findings and any changes implemented.

One of the limitations of this study is that there is no registry of PICUs in Argentina, so providers from only 23 facilities were contacted. Most likely, there are other facilities where TCD ultrasounds are carried out.

A strength of this study is that surveys were answered by the representatives of neurocritical care from each surveyed facility, whose training in TCD ultrasound was similar.

CONCLUSION

At least 20 PICUs in Argentina use TCD ultrasound in neurocritical patients. All surveyed participants use TCD ultrasound findings to decide on treatment or management. Half of the surveyed participants are little satisfied with their training in the pediatric field. The test results are not used for research purposes. ■

Supplementary material available at:
https://www.sap.org.ar/docs/publicaciones/archivosarg/2022/2408_CB_Figueroa_Annex.pdf

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